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December 31, 1963



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Dear [REDACTED]

Enclosed you will find our final report covering contract no. [REDACTED] together with the final accounting of the expenses incurred in conducting investigations and research and development projects, as covered by the above contract number.

In conjunction with the final billing, we wish to point out, that the contract was to cover two units as originally proposed, one for the Agency and one for [REDACTED]. However, as the final report indicates, the [REDACTED] portion was not forthcoming at the time the original contract was issued, due to some financial mixup between the Corps of Engineers and the Agency.

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We were informed officially at the time, that the Corps of Engineers was most definitely anxious to go along with the development project, since they were involved in all the preliminary negotiations and had outlined to us during the month of June their specific methods and requirements for a research and development project in general and this project in particular.

At that time they were under the impression ("they" meaning the representatives of the Corps of Engineers) that the contract had been issued and that their portion of it was included.

When we informed them in July, that we only received the portion covering the work for the Agency, they were quite unable to explain this peculiar development and insisted, that their portion would be included at an early date, since the monies had been transferred to the Agency in time.

As time progressed, we kept querying the Agency and [REDACTED] and were told in each instance to be patient, since there was no question about their requiring the particular unit and it was only a matter of internal bookkeeping to get this contract unraveled and back on the proper track.

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Since the two contracts together represented in excess of [REDACTED] and we are committed to complete a prototype, after conducting all of the necessary research and development functions, not later than 18 months from date of the original CIA contract, we had to procure additional engineering help or were fortunate at the time to acquire three qualified design engineers, namely [REDACTED]

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Due to the fact that the second portion of the contract had not as yet been received, we agreed to phase these people into their specific jobs on a staggered schedule one month apart. Therefore, we signed employment contracts with them guaranteeing minimum employment of one year; Mr. [REDACTED] starting September 15, 1963, [REDACTED] starting October 15, 1963 and [REDACTED] starting November 15, 1963.

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We also rented additional space in the building to provide for satisfactory security areas to conduct the necessary research, development and engineering functions and contracted for special testing equipment, which had been estimated as part of the contract.

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Therefore since the contract was terminated on October 9th for the convenience of the Government, with no default of any kind by [REDACTED], and, since we contracted to employ the above named research engineers for the time specified in good faith, we could not renege on the employment contract, and find ourselves at this point with three highly qualified research and design engineers for whom no appropriate space is available at this time.

Therefore, we believe that applying 90 days of their 12 month contract against Contract [REDACTED] is more than fair, since the people have been hired to conduct research and development and engineering functions for that specific contract only.

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In addition 90 days of the yearly commitment for the additional space, together with the cost of leasehold improvements to prepare the space for proper occupancy, is properly charged against the contract and in fact leaves us with the ability of finding other types of work in a hurry to employ the engineers profitably and to use the additional space as

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Some of the test equipment ordered for this contract could be cancelled; some of it had been received and is being used for [REDACTED] applications in general and, therefore, is not charged to the contract.

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We would appreciate having you audit our figures at your most earliest, since we, as a small organization, have a considerable amount of money committed in this contract and its termination and were depending on prompt progress payments to conduct the contract and find now that, due to the termination of this contract for the convenience of the government, no progress payments or any other payments will be made, until our figures are properly audited. Obviously, the earlier this audit can be accomplished, the less strain is placed on our finances and, therefore, the request for an early audit.

Thanking you for your prompt cooperation, we remain

Sincerely,

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Encl.

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FINAL REPORT

ON

CONTRACT 

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FINAL REPORT ON CONTRACT [REDACTED] TERMINATED FOR THE 25X1A  
CONVENIENCE OF THE GOVERNMENT ON OCTOBER 9, 1963

25X1A 1. During the contract negotiations it was decided, that the above contract will be jointly issued by two agencies, since both the CIA and [REDACTED] had expressed their interest in the proposed printer and their desire to have a specific model developed for them. 25X1A

25X1A 1.1 The basic requirements for both printers, CIA and [REDACTED] were identical, except for additional accurate lineup requirements for [REDACTED] which included reseau marks and some other specific points of accuracy.

25X1A 1.2 When the contract was issued, it only included one unit for the CIA and we were informed, that, for some unaccountable reasons, the transfer of funds from [REDACTED] to the agency had been misdirected and, therefore, the funds were not available at the end of the fiscal year. We were also informed, that these funds would be available very shortly after the beginning of the new fiscal and, therefore, we would get an extension of the contract, which would include the second item as required by [REDACTED] 25X1A

25X1A 1.3 During the month of June 1963 a conference was held on the premises of [REDACTED], which was attended by [REDACTED] re- 25X1A  
25X1A presentatives and during which all the specifications were thoroughly discussed, including the specific ones referring to the [REDACTED] order only.

25X1A 1.3.1 At that time the representatives of [REDACTED] indicated, that they were going along with the procurement and outlined their specific requirements, which stated, that no design activity shall be conducted on paper until the proper approach to each problem had been outlined in writing and submitted to their engineers for approval. 25X1A

25X1A 1.3.2 The next step, after approval had been received from [REDACTED] would be the actual layout of the design on paper, which subsequently would have to be submitted to [REDACTED] again for their approval and then the third step, the detailing of the design would have to be undertaken. 25X1A

1.3.3 After the completion of step #3, a new examination by [REDACTED] engineers was required, before actual building of the prototype could proceed.

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1.4 Therefore, when the actual contract did not include [REDACTED] part, we were handicapped in our research efforts, since we could not put anything on paper as per [REDACTED] instructions, before final approval from them was received. 25X1A

1.4.1 On the other hand, we could not delay the actual research and development project until the [REDACTED] extension was granted and therefore, we agreed to conduct various capability studies, to determine the best approaches to the designs involved and have these feasibility studies completed during the period, [REDACTED] was not yet included in the contract, so that, immediately after [REDACTED] part had been added, the various design parameters could be submitted for their approval. 25X1A

1.5 Up to October 9, the date the contract was terminated for the convenience of the government, [REDACTED] had not been included into the contractual agreement and, therefore, up to that date, all we could do, was theoretically pursue the various approaches to the solutions and accumulate the necessary research points of discussion to solve the design problems. 25X1A

1.5.1 At no point until October 9th were we informed that [REDACTED] would not participate in the research, development and design of the printer in question; as a matter of fact, even until the date of October 9th, we were not informed by the agency that there might be a termination in the offing.

1.5.2 We were told, during the visit by the agency representatives to our premises on September 22 and 23, that we should hold off expanding any larger research activities for a period of two weeks, while the agency was contemplating possible changes to the contract.

1.6 Therefore, this report, as indicated, contains a discussion of various points of approach involved in the solving of the problems of producing a printer as per specifications outlined with the contract.

2. The basic parameters for the design are as follows:

2.1 There must be no distortion from negative to positive film.

2.2 The image, at the time of exposure, must be in a perfectly flat plane.

2.3 There must be perpendicular light rays with respect to the film plane.

2.4 There must be perfect contact between negative and positive.

2.5 The mechanism shall be capable of clean operation and should not contaminate the environment.

2.6 The device shall provide flexibility of control over speed of operation, intensity of light, size and types of material to be printed.



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2.7 The above six specific parameters were investigated during the period of July 1, 1963 to October 9, 1963.

2.7.1 Item #2, which states there must be no distortion from negative to positive film, requires the careful examination of the film drive mechanisms, to make sure, that no undue stress was exerted on either the negative or positive film during the transport period, or while they were in vacuum contact with each other.

2.7.1.1 At the same time, considerable importance had to be assigned to the fact, that a very accurate film pulldown should be provided, so that the proper amount of film, both negative and positive, were fed out during the film advance steps, to insure, that no undue overlap or skip between frames occurs.

2.7.1.2 In this respect, we first examined the film drive mechanism itself and found that several approaches were open.

2.7.1.2.1 The most conventional type has a rubber coated film drive roller of a considerable diameter, this with a tension idler clamping the film to the diameter, while the roller is rotating. This design could be executed, either, by simply winding the film between the two rollers, such as a clothes mangle, with the drawback of possible film slippage and considerable pressure necessary on the tension idler to insure proper tracking of the film.

2.7.1.2.2 An alternate design of the same type, would provide for a considerable wrap-around of the film over the diameter of the drive roller and subsequent clamping of the film to the roller by means of a tension idler. This design would add to the contact pressure between tension idler and drive roller the additional surface friction of the film wrapped around the rubber coated roller itself.

2.7.1.2.3 Obviously, the longer the wrap-around path, that is, the larger the degree of wrap-around around the drive roller, the more friction would be exerted and with the same reasoning, the larger the drive roller, the more film would be wrapped around it and the more friction would be exerted thus minimizing any slippage incurred.

2.7.1.2.4 A third variant of the same basic idea, provides for two tension idlers and a reasonably large rubber coated drive roller; these two tension idlers being located in such planes, that they would provide for a considerable wrap-around, thus clamping the film at the entrance to the roller and at the point of exit.

2.7.1.2.4.1 This arrangement adds an extra tension idler and an extra clamping position, thus providing additional friction for a positive drive.

2.7.1.3 The disadvantages of the systems described, are in the



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fact, that a certain amount of distortion of the film itself is incurred, as the film is wrapped around the drive roller, which has a compressible friction surface, such as live rubber, and, which in fact might permanently distort the negative or positive film.

2.7.1.4 The last method, using a reasonably large rubber coated drive roller, with two tension idlers clamping the film around the roller at two points of contact, does seem to insure a reasonably slippageless drive, but, as stated previously, has some drawbacks, which do not make it completely satisfactory.

2.7.2 Another method was carefully investigated; that is, using a suction roller, which would hold the film to its surface by suction and release it as the roller rotated around its diameter.

2.7.2.1 In this respect, various experiments were conducted and basic design sketches produced on the blackboard, to determine the feasibility of a proper design, where part of the diameter of a roller would be under suction, thus holding the film securely to its surface, and still permitting the revolving of the drum, in this instance around a stationary member providing the suction feature, so that, as the drum revolved, the suction would be released at a specific point of the stationary member, and thus the film released, once it has been carried to that point.

2.7.2.2 Satisfactory ideas have been evolved, to carry film in this fashion over a perforated drum and a stationary suction member inside the drum, which would permit the revolving of the drum and the gradual release of suction as the drum reached a specific point around the stationary member inside of it.

2.7.2.3 It was felt, that this type of a film drive would most likely produce slippage free movement of the film, without any appreciable distortion of the film itself and at the same time, prevent any possible pressure marks caused by tension idlers, while the film was stationary during the exposure cycle.

2.7.3 A second problem, which had to be properly examined, was the question of how to produce reasonable film tension, while the film was advanced from one station to the other, without creating undue stress and thus possible distortion in the image area.

2.7.3.1 For this purpose, various brake arrangements were carefully considered, to determine which had the most promise of performing the specifications as outlined above.

2.7.3.2 Here again the question of brake rollers, with brake surfaces, such as rubber, and tension idlers were considered and various design sketches examined, to determine, whether they fulfilled the specifications of minimum distortion. Again it was felt, that most likely a combination vacuum drum, similar to the driving drum, coupled to a friction disk, with adjustable friction tension, might have the most promising design parameters.

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2.8 Item #2.2 of the specifications states, that the image, at the time of exposure, must be in a perfectly flat plane. This item requires primarily the provision, that the glass plate, against which the two films are held by vacuum, should be an optical flat and properly supported, so that it didn't create any distortion, while the vacuum was applied against it.

2.8.1 Therefore, it involved primarily, the examination of satisfactory support members for the glass plate, which in this instance was at least 10" wide and 54" long, and the feasibility of procuring satisfactory optical glass flats, preferably with a high ultra violet ray transmission capability, in the size, as indicated above.

2.8.1 Here again considerable investigations were conducted, to ascertain sources of supply of such materials, and in addition engineering aspects were considered, how the glass flat could be supported in relation to the rubber blanket producing the vacuum contact, and the light source traveling above it.

2.8.1.1 Considerable time was spent in developing blackboard sketches of support members and allied components and discussing the advantages and disadvantages of various design approaches.

2.9 Item 2.3 specifies, that the light rays are to be absolutely perpendicular to the film plane at the time of exposure. This specification requires the examination of optical members, to be placed between the light source, or light sources, and the film plane, so that proper collimation of the light is to be accomplished at the point of film exposure.

2.9.1 One major problem had to be resolved, and that was the fact that this printer was to be experimental and, therefore, arranged so, that varying components of light sources could be tested, to determine their usefulness in printing aerial negatives.

2.9.2 Some of these light sources were to be of the pinpoint type, others were tubular, extending across the full width of the film, and each one required a different treatment of optical components, to produce collimated parallel light beams at the film plane.

2.9.2.1 Therefore, considerable time was spent in examining the various light sources, that might be used for the printing applications, and their interrelation with optical components; also a means of providing interchangeable supports for the various components in the printer and the different design characteristics necessary, to reconcile the various support requirements in question.

2.10 Item 2.4 specifies, that there must be perfect contact between negative and positive. For this purpose, the production of vacuum by means of a rubber blanket was carefully considered. It was also necessary to determine the availability of special types of rubber

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and special designs of rubber blankets, since it was important to produce perfect contact as specified and at the same time prevent marring and damaging of the films at the point of the blanket seal.

2.10.1 This required considerable investigation of sources of rubber and designs of blankets. The engineering aspects of supporting the blanket in position in relation to the glass frame had to be carefully considered, since the film drive mechanism was to be located immediately adjacent to the ends of the blanket and sufficient release between blanket and glass had to be provided, to permit the free travel of both films, without either one touching any of the components, thus preventing any possible damage to the film itself.

2.11 Item 2.5 specifically states, that the mechanism shall be capable of clean operation and should not contaminate the environment. This required, the careful examination of the design itself as to drive members and mechanical and electrical components and in addition the design parameters of the outside case, to make sure, that there were no sharp corners or nooks, in which dust could accumulate and, that all the necessary covers had been designed according to the best examples of clean room operation, with a minimum capability of producing or accumulating dust particles.

2.12 Item 2.6, which basically specifies, that the mechanism shall be designed for research and development purposes and to provide flexibility of control over speed of operation, intensity of light, sizes and types of materials to be printed, produced a considerable design activity and research and development, since first the various means of operation have to be carefully considered and decisions made, as to the most feasible design for each point as outlined.

2.12.1 For instance, film drive had to be flexible to an extent, where not only the length of the film image advance had to be variable to a considerable degree, but at the same time, once it had been locked into a specific advance length, such a length had to be maintained to a high degree of accuracy.

2.12.2 For these purposes, various means of metering film and driving film had to be carefully considered and a means of varying the metering unit in addition investigated.

2.12.2.1 The variability of the film drive produced a major design problem since, as stated previously the accuracy of this film drive advance had to be maintained. In that respect another point had to be carefully examined, and that was the possibility of using various film widths from 70 mm to 9-1/2" and guiding these widths on the film drive rollers, brake rollers and through the free length of the film, exceeding 54", so that the two films negative and print film, would properly stay in line and contact each other without any weave or offset in relation to each other.

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2.12.3 A major effort was exerted in this respect to try to prove the validity of the argument, that a flat vacuum contact in contact printing will produce better resolution and less distortion than a continuous rotary printer, where the two films are kept in contact and exposed over the diameter of a drum.

2.13.3.1 For that purpose various experiments were conducted with the following parameter arrangements.

2.12.3.1.1 First, to eliminate the possibility of film stretch and shrinkage, due to various atmospheric conditions and due to processing, cronar base material was used throughout.

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2.12.3.1.2 Secondly, a [REDACTED] PD302 printer was adapted with varying diameter drums, from 3" to 6", and in addition, a [REDACTED] kalvar printer, a [REDACTED] diazo printer and [REDACTED] diazo printer were used.

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2.12.3.2 Each one of these three last named printers employ a transparent glass drum of about 4" in diameter, where the negative film is on the inside and the positive film on the outside.

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2.12.3.3 The PD302 [REDACTED] printer is equipped with an opaque drum and the film exposed, as it is carried past a printing slot, so that, the negative film is on top of the positive film over the drum while it is being printed.

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2.12.3.4 The negative film in this instance was produced in a [REDACTED] PD1088M camera, which is equipped with an 1-3/4" long aperture and a DOQ spec 2" pull down.

2.12.3.4.1 Therefore, the total film advance per cycle on the 35 mm film used in this instance, is 2"  $\pm .020$   $-.000$ .

2.12.3.5 Once the negative film had been developed, it was carefully checked for accuracy of pulldown and it was found that a total of 600 images represented 1,205.460".

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2.12.3.6 This film then was used as a master and first printed on the [REDACTED] printer, using a 3" diameter printing drum; then this drum was replaced with a 4", 5" and then finally the standard 6" drum, which normally is part of the printer.

2.12.3.7 In each instance a full roll of the master negative was run on the machine in contact with cronar base positive emulsion; the positive emulsion developed in the same processor as the negative and then the length of the film accurately checked.

2.12.3.7.1 Using the 3" drum, the length of the positive was 1,202.385".

2.12.3.7.2 Using the 4" drum, the total length of the positive representing 600 frames was 1,203.460".

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2.12.3.7.3 Using the 5" drum, the length of the positive was 1,203.950".

2.12.3.7.4 Using the 6" drum, the length of the positive was 1,204.005". 25X1A

2.12.3.7.5 When the same film was printed on the [REDACTED] Kalvar printer, the length of the Kalvar positive representing the same 600 frames of silver negatives was 1,209.160".

2.12.3.7.6 The [REDACTED] diazo printer produced a duplicate negative from the silver negative and its length measured 1,207.605". 25X1A

2.12.3.7.7 The same film printed on the [REDACTED] diazo printer measured 1,207.685".

2.12.3.8 These experiments confirmed the thesis, that, using a rotary printer, the two films in contact with each other, will not have the same finished length, regardless of the stability of the base used, due to the fact, that the speed of the two films, one traveling on the diameter of the drum and therefore, carried by that drum, the other carried on top of the drum, plus the film directly in contact with the drum, will therefore, assume a different speed and produce a longer strip of film.

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2.12.3.9 To prove the validity of this statement, the experiments were repeated on the diazo printers and the [REDACTED] printer and the results obtained were in each instant reasonably comparable to the results obtained the first time and any variations, which were within small fractions of an inch, could be attributed primarily and solely to slippage, in addition to the variable speed of the two films, developed by faulty design of the film drive mechanism.

2.12.3.10 Since these experiments prove reasonably conclusively the thesis, that a continuous rotary drum printer will distort the positive image in relation to the negative, in inverse ratio to the size of the printing drum used; one important point of the straight line contact printers superiority over a continuous roll printer has been proven without a doubt.

2.12.3.10.1 Regardless of the additional argument advanced, that at the point of contact emulsion to emulsion, the relative speed of the two films should be identical, and even this point is wide open to discussion, the fact remains, that, if the print film is to be used for photogrammetric measurements, it will not represent a true picture of the images as originally preserved on the negative, since each frame will be either larger or smaller, than the corresponding negative frame depending on whether the printer has a light source on the outside of the drum, or a glass drum with the light source contained within the drum.

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2.12.3.11 If the positive film is to be used for photogrammetric measurements, the results obtained will not be accurately representing the images contained in the master negative, due to this elongation or contraction of the positive print as exposed and produced over a continuous rotary drum printer.

2.13 Another set of experiments were conducted, to determine, whether the rotary printer has capabilities of producing satisfactory resolution, which compares with the resolution obtained in a vacuum printer with properly collimated light.

2.13.1 Therefore, a 35 mm negative image, containing approximately 150 line resolution, was printed in three different fashions; the print film used in this instance was high resolving microfilm positive with a reasonably high contrast ratio.

2.13.2 The print methods were as follows:

2.13.2.1 The negative was exposed in a vacuum frame, with a ten watt zirconium pinpoint light source and proper collimating condensers.

2.13.2.2 The same image was exposed, stationary in position, underneath the printing slot of a PD302 [REDACTED] printer, with sufficient tension on the negative film to hold the positive in good close contact.

2.13.2.3 The same negative film was contacted in a PD302 Continuous Roll Contact Printer, while both the negative and positive were in normal movement around the periphery of the drum, with the printing slot set at about .100" and the speed of the printer 90 ft. per minute.

2.13.3 The light source in the PD302 printer is normally a 75 watt projection bulb, with proper collimating condenser, to produce parallel light beams at the printing slot.

2.13.4 The results obtained were as follows:

2.13.4.1 In the printing frame the resolution read, off the duplicate positive was 150 lines. This seemingly perfect result can be explained by the fact, that the resolution target in the negative film had no fine enough symbols to accurately determine the inherent resolution of the negative, since the change of symbols from five, which at 30 reductions represents 150 lines to the next higher symbol 5.6 is a step of 18 lines in addition, that is, 5.6 will represent an inherent resolution of 168 lines, and the negative showed better than 5, but not sufficiently high resolution to assume that it was 168 lines.

2.13.4.1.1 Since we did not have a microdensitometer, so that an accurate trace could be run over the negative, to determine an



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approximate estimate of a resolution within the two limits of 168 or 150 lines, we assigned a value of 150 plus and found in the positive, printed in the vacuum frame and collimated zirconium light, a resolution of 150 also plus but not as clearly plus as the negative.

2.13.4.2 The stationary contact print, produced on the periphery of the drum, through a .100" slot and a 75 watt projection lamp, properly collimated, showed in the positive a resolution, which had to be gauged as 150 lines minus, since it was in effect 150, but by no means clear and sharply defined as the negative and, therefore, on the minus side. Estimating a loss factor of about one half target.

2.13.4.3 On the continuous printer, in normal operation, the resolution showed up as a 135 line plus, that is the 4.5 target was clearly and sharply defined and the 5 target was not sufficiently defined, therefore, the loss factor was most likely a one (1) target minus; that is actually less than one target, but no means to determine how much less than one target.

2.13.4.5 These experiments were repeated several times, with the results comparable in each instance, even though the exposure times and processing cycles were varied to produce varying contrasts in the print film.

2.13.4.6 In fact no appreciable change in the results was observed until the contrast was reduced by about 30%. Beyond that point, the resolution loss started increasing and when the contrast reached a 50% drop the loss factor was increased about 50% in each instance.

2.13.4.7 When the contrast was reduced 70%, the loss factor increased considerably and the results as obtained were as follows:

2.13.4.7.1 In the vacuum frame, the best reading was 105 line resolution.

2.13.4.7.2 In the continuous printer with a stationary exposure, the best reading was 90 lines.

2.13.4.7.3 In continuous movement, the best reading was 84 lines.

2.13.5 Since the PD302 printer is the standard of the microfilm industry, and has been used for years in every microfilm laboratory for quality duplicating of microfilm images, requiring the highest resolution capability, the loss factor involved cannot be attributed to an inferior printer design, but is inherent in the fact, that perfect contact cannot be established or maintained in a continuous rotary drum printer, without producing considerable distortion and pull on the negative film wrapped over the positive or vice versa, which in itself defeats the basic requirements of such printers, to have minimum distortion, and even in cases, where

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considerable tension is produced by brake tensions on one end and drive tensions on the other, no guarantee of continued perfect tension is available and slippage may occur at any time to disturb the resolution transfer, provided it can be accomplished satisfactorily in the first place.

2.13.6 These tests confirm the fact, that, for perfect transfer of resolution and undistorted image length and configuration, a straight line vacuum pressure contact is required and, therefore, has to be properly incorporated into a satisfactory contact printer.

2.14 A considerable effort was expended in examining various sources and means of modulating the light intensity, either across the width of the printing slot, to balance densities encountered across the width of the print negative, or along the travel of the light itself, over the exposure area to balance variations of negative density along its lengths or from frame to frame.

2.15 To vary the light intensity along its travel, three means of variables are available.

2.15.1 The light intensity itself can be varied, maintaining constant slot width and constant speed.

2.15.2 The light intensity can be maintained constant and instead the speed of the light transport varied thus varying the exposure.

2.15.3 The width of the printing slot could be varied, maintaining the other two components constant.

2.15.4 Each one of these methods might have some advantages and disadvantages and, therefore, considerable time was spent in examining each method, the means of achieving results as indicated and advantages or disadvantages involved in applying the variables.

2.15.5 The first question to decide was, whether there was any advantage involved in varying the light intensity across the width of the slot and in addition along its travel.

2.15.5.1 Obviously a 9-1/2" widefilm, as exposed by an aerial camera over varying terrain, will encounter all types of ground colorings and lighting conditions, so that the image across the width will vary in intensity to a great extent.

2.15.5.1.1 As the [REDACTED] systems, of feedback through an oscilloscope tube, has proven, a varying intensity across the width of the image and of course, across its length, does produce better contrast, evening out highlights and shadows. The oscilloscope approach, however, creates some basic problems, which obviate its possible use for this contact printing application.

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2.15.5.1.2 One of the major problems, in using an oscilloscope as a light source, is the impossibility of collimating the light beams properly. Another is the lack of light intensity, which would not permit the speeds, that were to be incorporated into the printer.

2.15.5.1.3 Still another drawback is strictly mechanical; due to the fact that the light emanates from the face of the oscilloscope tube, the entire tube has to be transported across the length of the film and at the same time modulated in a narrow band to suit the reflected densities of the negative across the width of the film and along its length.

2.15.6 Since the flying spot scanning approach, as used in an oscilloscope tube printer, cannot be properly incorporated into the design as it was proposed originally, alternatives of modulating the light intensity across the width of the film had to be carefully examined.

2.15.6.1 The only possible answer, that could have been employed for this specific design purpose, was, modulating the slot width in sections to suit the densities encountered in the negative.

2.15.6.2 This approach, however, has considerable mechanical problems and a considerable effort was exerted in trying to find a reasonable solution.

2.15.6.3 Modulating the slot width, as such, has been successfully employed in some motion picture printers and, therefore, does not produce any real difficulties. The problem was, however, in modulating sections of the slot and, therefore, it becomes quite difficult to try to link up one section with heavy densities to an adjacent section that has light densities, without producing either a very abrupt change of density or a gradual slipover, which does not actually represent a true picture of the negative densities encountered. In either case, after considerable discussions and blackboard sketches, the method of varying exposures across the width of the film, by means of varying slot widths, was discarded at this time.

2.15.7 At the same time, the basic principle of varying slot width to control exposures, was thoroughly investigated and means have been discussed to vary the slot widths by feed back from a photocell or for that matter, a series of photocells, which could be averaged to get a slot width representing average densities across the width of the film. This approach is quite feasible and could have been incorporated into the final design with possibly satisfactory results.

2.15.8 Another method, as previously stated, was the varying of the printing light speed, as it traveled over the film. This method could be easily incorporated, since the output of the photocell, or a series of photocells averaged, could be easily converted into voltages, applied to a DC drive armature, thus varying the motor speed successfully in direct ratio with the reflected light variance.

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2.15.8.1 In this respect, some experiments were conducted to determine the feasibility of reflecting light off the positive emulsion, which normally is of a white or a nearwhite color and, therefore, is a suitable background for the negative densities encountered.

2.15.8.2 This method was found to be satisfactory, either by reflecting through the printing slot itself, and picking up the reflected light through a series of photocells, so that the representative values of densities across the width of the film were properly integrated, or through a red filter, which was directly in front of the printing slot, so that the film was prescanned and to some extent the actual variations of speed accomplished at the printing slot, while the light source was traveling over the area to be exposed.

2.15.9 The third method investigated, was the actual varying of light intensities, again by feeding the output of photocells, through a suitable circuit, into the input of the light itself and thus increasing or decreasing the light intensity, in inverse ratio to the intensity of the reflected light values as read by the photocells. This was necessary, since the lower the inherent density of the negative and, therefore, the higher the reflected light value, the less light is necessary to print it out satisfactorily.

2.15.9.1 Circuit sketches were produced on the blackboard, to illustrate the possibility of properly inverting the output of the photocells and producing the corresponding voltage inputs for a light, which was properly affected by variations in input voltage and thus the intensity increased or decreased in proportion.

2.15.9.2 For this purpose various light sources were carefully examined, to determine their suitability for such a photo-electric control and it was found, that a zirconium type light had the best response to voltage changes and, therefore, was more suitable for such a controlled application as described above.

2.15.9.2.1 This light was originally developed during the war to transmit voice modulations over a light beam, which could be directed to a specific receiving spot and kept so narrow, that no interception of the message was possible, except by a medium, which was directly in line with the light source itself.

2.15.9.2.2 The zirconium arc light was found to be most suitable at the time for producing a very narrow light beam by proper collimation of condensers and reflectors and at the same time had the capability of changing intensity directly proportional to the voltage input of the light source itself and thus produce a modulated light, which, when intercepted at the receiving end could be transformed into proper electronic impulses to modulate a speaker of sorts.

2.15.9.2.3 Thus it was possible to speak over a light beam, from

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one point to another, as long as there was no obstruction in the way, that means the light could be directly beamed at the receiver.

2.15.9.2.4 Since this light source also has a very high inherent intensity for input of wattage employed and is used as a pinpoint source for varying enlarging and printing application, it was carefully investigated for this specific application, to determine its capability of covering a slot width of 9-1/2" maximum and at the same time travel at a speed fast enough to expose negatives of a given background density within the time limits specified in the contract.

2.15.9.2.5 By simple experimentation it was established that a 100 watt zirconium bulb would be capable of accomplishing the above aims without difficulty.

2.15.10 In addition, various tubular light sources were investigated, to determine their usability for such a modulated application.

2.15.10.1 One of the sources investigated was the new iodine vapor arc light, which has the advantage of maintaining constant light intensity for the life of the tube, without any blackening of the glass envelope or loss of intensity due to change of the filament used. This source, as used, would be satisfactory for printing applications due to the above named specifications, but the response to change of voltages is not sufficiently great or for that matter fast enough in response to be usable with a modulated light intensity.

2.15.11 Other light sources investigated were mercury vapor, concentrated arc and tubular light sources; also some of the newer xenon mercury vapor and xenon light sources, with concentrated arcs and tubular types, plus a pulsating xenon arc, which has been used quite satisfactorily for lithographic illuminating purposes.

2.15.12 No final conclusions have been made as to the best light sources for the specific printing applications in question, but several design criteria have been set up, to permit the interchangeability of some of these light sources in the mechanism.

2.16 Several methods were examined to determine the best medium of reading negative densities and using the photocell readouts for the control of exposures as previously discussed.

2.16.1 One of the methods was the direct reflection of the light from the positive emulsion.

2.16.2 Others were prereading of negative densities and various means of establishing memory circuits, so that the preread densities could then be reconverted into proper light values at the exact point of printout.

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2.16.2.1 In this respect one of the methods examined was establishing a magnetic tape readout as the negative film is advanced over a constant intensity light, ahead of the printing area, and then feeding this magnetic readout back through the proper circuitry to either control the width of the slot, the speed of the print light or the intensity of the light, at the time that particular area of film was to be printed in contact.

2.16.2.2 A similar method was, to readout and record the readouts on a paper tape, and then reread the paper tape, at the same speed as the printing light travel, and thus be able to establish an exact relationship, between the readout medium such as magnetic or paper tape and the film as it was printed in the contact frame.

2.16.3 In examining each one of these methods, problems had to be looked at, in relation to the proper reading of densities first.

2.16.4 Secondly, the proper recording of the readouts on various recording media such as magnetic tape or paper tape and...

2.16.5 Thirdly, the correlation of the printout area on film with the proper area on the memory medium such as magnetic or paper tape.

2.16.6 One possibility was examined with considerable care and that was the possibility of precoating a magnetic strip alongside the negative film before it was placed into the printer and then recording on that magnetic strip the varying densities as they were encountered in the picture area and finally reading that magnetic strip, as the light was travelling over the area, and converting the readout into the appropriate exposure controls.

2.16.6.1 This method would establish a permanent control record, so that, once the film was to be reprinted anytime in the future, it would not be necessary to re-establish density readings, since the readings would be permanently recorded alongside of the image and available for new controls whenever required.

2.16.6.2 This method of course required the examination of various methods of coating exposed film negatives after processing with a magnetic carrier band; also establishing a method of recording density readouts on this magnetic tape in a fashion, so that, when it was used again, it would properly actuate the controls, which in effect would modulate the exposure in direct proportion to the densities encountered.

2.16.6.3 Finally, answers had to be found to the question of how these coatings could be applied to varying widths of film as specified in the basic design parameters, and how the magnetic readout medium could be positioned to fit the different widths of film and still be able to pick up the modulated magnetic information as required.



2.17 Considerable discussions were conducted, on the basic circuitry of the electrical and electronic controls, to be incorporated into the printer, which would permit the flexibility, as described in the basic specifications.

2.17.1 This flexibility, included the possibility of printing a number of duplicate images from the same negative area, or the automatic establishment of a cycling operation where a number of duplicate images would be printed and then the negative film advanced a predetermined amount of inches and the same cycle repeated over and over again.

2.17.2 All of the variants, as spelled out in the basic specification of the contract, require a considerable flexibility in the electrical and electronic circuitry of the design and, therefore, considerable effort had to be exerted in determining, how these specifications could be fulfilled in the simplest and the most effective way.

END OF REPORT

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VARYING LENGTHS OF POSITIVE FILM WITH  
DIFFERENT PRINTERS AND DRUM DIAMETERS

TABLE NO. 1

PRINTERS	NEG. LOCATION	LENGTH OF NEG.	LENGTH OF POS.
PD 302 WITH 3" DRUM	OUTSIDE	1,205.460"	1,202.385"
PD 302 WITH 4" DRUM	OUTSIDE	1,205.460"	1,203.460"
PD 302 WITH 5" DRUM	OUTSIDE	1,205.460"	1,203.950"
PD 302 WITH 6" DRUM	OUTSIDE	1,205.460"	1,204.005"
25X1A [REDACTED] WITH 4" DRUM	INSIDE	1,205.460"	1,209.160"
25X1A [REDACTED] WITH 4" DRUM	INSIDE	1,205.460"	1,207.605"
25X1A [REDACTED] WITH 4" DRUM	INSIDE	1,205.460"	1,207.685"

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RESOLUTION IN PRINTFILM WITH DIFFERENT  
PRINT METHODS AND VARYING LINE DENSITIES  
IN PRINTFILM.

TABLE NO. 2

PRINTER	BACKGROUND DENSITY	RESOLUTION OF NEG.	RESOLUTION OF PRINTFILM
VACUUM FRAME	1.8	150 LINES +	150 LINES
PD302 STATIONARY	1.8	150 LINES +	150 LINES -
PD302 ROTARY	1.8	150 LINES +	135 LINES

TABLE NO. 3

PRINTER	BACKGROUND DENSITY	RESOLUTION OF NEG.	RESOLUTION OF PRINTFILM
VACUUM FRAME	0.9	150 LINES +	135 LINES +
PD302 STATIONARY	0.9	150 LINES +	135 LINES
PD302 ROTARY	0.9	150 LINES +	120 LINES

TABLE NO. 4

PRINTER	BACKGROUND DENSITY	RESOLUTION OF NEG.	RESOLUTION OF PRINT FILM
VACUUM FRAME	0.6	150 LINES +	105 LINES
PD302 STATIONARY	0.6	150 LINES +	90 LINES
PD302 ROTARY	0.6	150 LINES +	84 LINES

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